



# ACOUSTICAL STUDIES OF ZINC ACETATE AND ITS STATISTICAL INTERPRETATION

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## ABSTRACT

The structure of liquids are less well established than that of gases or solids. Despite a great deal of research in this area, we still do not have a clear picture of the way in which molecules are arranged in even the most common liquid, water. We do, however, have a reasonably detailed knowledge of the average distances between atoms or molecules in a liquid. Moreover, we can estimate with considerable accuracy the magnitude of the forces between particles in a liquid. Since the molecules in a liquid are much closer together than those in a gas, attractive forces between molecules are considerably stronger.

The Scientist A. PASSYANSKI gave the Signal Acquisition in Ultrasonic systems. Compressibility is explained by assuming that the molecules are fully compressed. The compressibility of the solution is mainly due to free solvent molecules. this was given by S.BARNARTT. W.SCHAFF HAS been engaged on the study of importance of Molecular interaction between the acceptor and the Donor molecules.

In India V.A.TABHANE worked on the Acoustical study of organic materials. The internal pressure and free volume analysis for Aqueous solution of Pinacol was given by S.Sekar and A.Dhanalakshmi. The Molecular interaction studies on liquids by Viscometric / Ultrasonic techniques was given by J.B.THAKARE, D.T.DONGRE & DEOGANKAR. The measurement of Experimental Ultrasonic velocity of organic substances was given by S.JAYAKUMAR, V.KANNAPPAN, S.SUBRAMANIAN and others. The study of Molecular interactions has inspired many researchers and extensive investigations have been carried out in aqueous solutions.

## Introduction:

The energy of perfect gas is the sum of the internal energies and the transactional kinetic energies of the individual molecules, the intermolecular potential energy being zero. The inter-atomic or vibrations have low potential energies. However in this case also an adequate partition function can be obtained. In a liquid Cohesive forces are not strong enough to present a considerable transactional energy to individual molecules. A liquid shows short range ordering in space. Ultrasonic studies of electrolytic solutions yield valuable information about the nature and strength of molecular interactions. The estimation of ultrasonic velocity helps to evaluate the internal pressure and free volume of solutions.

Internal pressure of liquids provides a wealth of information about the state of liquid. It explains many of the properties of liquids and solutions. Internal pressure though a single factor appears to vary due to all the internal interactions such as hydration of solute solvent interactions.

The effect of temperature and concentration on internal pressure and free volume are studied and quantitative relationships are established. The dependence of internal pressure and free volume on each other is also checked.

## Experimental studies:

The aqueous solutions of Ammonium and calcium sulphate (AR Grade) is dissolved in double distilled water for making up different concentrations under study. A Mittal type fixed frequency Interferometer (2 MHz) is used for the determination of Ultrasonic velocity. A 10 ml specific gravity bottle & cannon Fenske Viscometer was used for determining both density & viscosity of the solutions respectively. A circulating thermostat to maintain the temperature of the system constant for temperature variation studies.

## Mathematical formulas:

$$\text{Intermolecular free length } (L_f) = \left( \frac{K}{U_p^{1/2}} \right) = K(\beta_{ad})^{1/2}$$

$$\text{Ultrasonic Velocity } (U) = \lambda \times f$$

$$\lambda = \text{wavelength } f = \text{frequency}$$

$$\text{Where } \lambda = 2d/n$$

$$\text{Relaxation time } (\tau) = 4\eta / (3pU^2)$$

$$\text{Rao's Constant } (R) = R = \frac{M}{\rho} \cdot u^{1/3}$$

$$\text{Wada's Constant } (W) = \left[ \frac{M}{\rho} \right] (\beta_{ad})^{-1/7}$$

## Results and Discussion

The experimentally determined values of ultrasonic velocity for Zinc Acetate at temperatures 303K, 313K and 323K are summarized in the table.

The measurement of ultrasonic velocity is an important tool to study the physical & chemical properties of the liquid. Ultrasonic velocity and allied temperatures are presented graphically in figures.

The parameters derived from ultrasonic measurements such as adiabatic compressibility, acoustical relaxation time, intermolecular free length, specific acoustic parameters for Ammonium and calcium sulphate for various concentrations, at different impedance, molar sound velocity and molar compressibility prove a better insight into molecular environment in liquid mixtures and solutions.

In this the ultrasonic velocity increases with increase in both temperature and concentration.

The plots between the ultrasonic velocity and concentration potential shows that the ultrasonic velocity is found to linearly increase with temperatures. This linear increase suggests that there are strong solute-solvent interactions in the liquid solution. These interactions are both concentration and temperature dependent. The effects of temperature on the interactions are more than that of concentration. At low concentrations, the number of hydrogen bonds formed may be less and at higher concentrations, it may be more due to solute-solute interactions [Graph 1].

The intermolecular free length of the liquid systems decreases with increase in concentration. The free length is the distance between the surfaces of the neighboring molecules. It indicates significant interactions between the solute and solvent molecules, due to which the structural arrangement in the neighborhood of constituent solute particles is considerably affected. At lower concentrations, the molecules are not closer and then the intermolecular free length will be high [Graph 2].

The variations of molar sound velocity (Rao's constant) and molar compressibility (Wada's constant) show both trend with the variation of temperatures as expected [Graphs 4,5]. Any modifications induced by the solute on the local structure of the solvent generate changes in the solutions and therefore it can be used to characterize solvated properties of solute in dilute solutions.

Acoustical relaxation time of all the systems studied here, is found to decrease with increase in temperatures. It is directly proportional to adiabatic compressibility and viscosity. These changes with respect to concentrations are not similar to those found in adiabatic compressibility. These changes in acoustical relaxation time with respect to concentrations and temperatures are

similar to those found in viscosity[4]. This supports the view that viscous forces play a dominant role in the relaxation processes [Graph 3].

From the statistical Interpretation the values of  $R^2$  for ultrasonic velocity agrees with the results of ultrasonic studies.

The values of  $R^2$  For the intermolecular Free length, Free volume also agrees better with the Results of ultrasonic studies.

**Velocity (U) (m/s)**

Mol/Temp	303k	313k	323k
0.1	1519	1618	1652
0.2	1570	1624	1663
0.3	1585	1613	1664

**Intermolecular free length ( $L_f$ )(mt)**

303k	313k	323k
0.006605	0.005709	0.005616
0.005864	0.005688	0.005578
0.005761	0.005498	0.005352

**Relaxation Time ( $10^{-13}$ sec)**

Mol/Temp	303k	313k	323k
0.1	6.864	3.62	3.14
0.2	8.959	3.59	3.01
0.3	9.276	4.68	3.25

**Rao's Constant**

303k	313k	323k
932.143	914.235	937.378
884.042	917.609	943.620
885.203	874.938	906.421

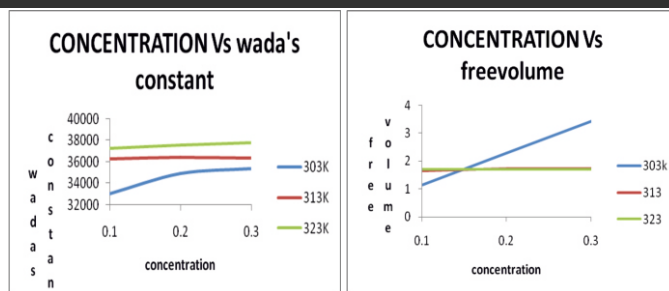
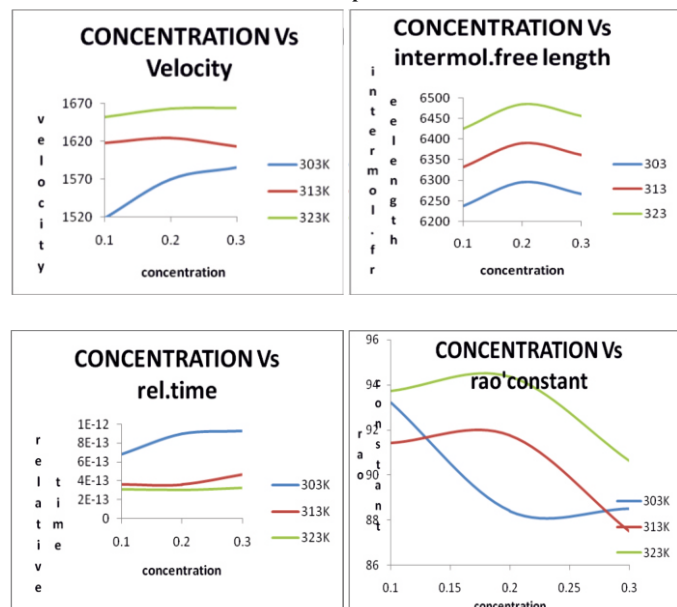
**Wada's constant (W)**

Mol/Temp	303k	313k	323k
0.1	330.32	362.50	372.10
0.2	348.90	364.23	375.29
0.3	353.61	363.17	377.77

**Free volume ( $V_f$ )(mt):**

303k	313k	323k
0.1146	0.1665	0.1697
0.2293	0.1721	0.1704
0.3440	0.1738	0.1692

**Graph**



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